Patent Claims

1. Electric camshaft adjuster for adjusting and securing the phase angle of a camshaft of an internal combustion engine with respect to its crankshaft,

- having a drive wheel (1) which is connected fixedly in terms of rotation to the crankshaft,
- an output component (4) which is fixed to the camshaft, and
- a harmonic drive
- having at least one ring gear-spur gear pairing,
- one of the two components being connected fixedly in terms of rotation to the drive wheel (1), and the other component having at least a torque-transmitting connection to the output component (4),
- the spur gear being embodied as a flexurally elastic sleeve (18) and
- being arranged at least partially within the first ring gear (2, 5),
- having a wave generator (17, 17', 17'') which is driven by an electric adjustment motor by means of an adjustment shaft (10, 10', 10'', 10''') which is fixed to the gearing,
- which wave generator (17, 17', 17'') has means for elliptically deforming the flexurally elastic sleeve (18),
- as a result of which the sleeve (18) is deformed in such a way that a torque-transmitting connection is formed between the ring gear (2, 5) and the sleeve (18) at two points on the sleeve (18) lying opposite one another, characterized in that at least one of the gears of the ring gear-spur gear pairing is formed in one piece with the drive wheel (1) or output component (4).

2. Electric camshaft adjuster for adjusting and securing the phase angle of a camshaft of an internal

combustion engine with respect to its crankshaft,

- having a drive wheel (1) which is connected fixedly in terms of rotation to the crankshaft,
- an output component (4) which is fixed to the camshaft, and
- a harmonic drive
- having at least one ring gear-spur gear pairing,
- one of the two components being connected fixedly in terms of rotation to the drive wheel (1), and the other component having at least a torque-transmitting connection to the output component (4),
- the spur gear being embodied as a flexurally elastic sleeve (18) and
- being arranged at least partially within the first ring gear (2, 5),
- having a wave generator (17'') which is driven by an electric adjustment motor by means of an adjustment shaft (10'', 10''') which is fixed to the gearing,
- which wave generator (17'') has means for elliptically deforming the flexurally elastic sleeve (18),
- as a result of which the sleeve (18) is deformed in such a way that a torque-transmitting connection is formed between the ring gear (2, 5) and the sleeve (18) at two points on the sleeve (18) lying opposite one another, characterized in that
- the means for elliptically deforming the flexurally elastic sleeve (18) are two bearing journals (29) which are attached to the adjustment shaft (10'', 10''') and bear against two regions of the sleeve (18) lying opposite one another, a roller bearing (13''') being arranged on each of said bearing journals (29).

3. Camshaft adjuster according to one of Claims 1 or

2, characterized in that the sleeve (18) is of pot-shaped design.

4. Camshaft adjuster according to one of Claims 1 or 2, characterized in that a second ring gear (5) is arranged in the axial direction next to the first ring gear (2) and coaxially with respect thereto, the sleeve (18) is arranged at least partially within the second ring gear (5) and enters into a torque-transmitting connection with the second ring gear (5) at two points lying opposite one another.

5. Camshaft adjuster according to one of Claims 1 or 2, characterized in that the torque-transmitting connection between the ring gear (2, 5) and the sleeve (18) is implemented by means of an external toothing (28) of the sleeve (18) which engages in an internal toothing (3, 6) of the ring gear (2, 5), and the number of teeth of the internal toothing (3, 6) of the ring gear (2, 5) differs from the number of teeth of the external toothing (28) of the sleeve (18).

6. Camshaft adjuster according to one of Claims 1 or 2, characterized in that the torque-transmitting connection between the ring gear (2, 5) and the sleeve (18) is implemented in a frictionally locking fashion by means of the interaction of the smooth internal lateral face of the ring gear (2, 5) and the smooth external lateral face of the sleeve (18).

7. Camshaft adjuster according to one of Claims 1 or 2, characterized in that the electric adjustment motor is preferably embodied as a brushless DC motor (BLDC motor) which is operated in bipolar fashion and has a stator fixed to the cylinder head and preferably a rare earth magnet.

8. Camshaft adjuster according to one of Claims 1 or

2, characterized in that the motor shaft of the BLDC motor and the adjustment shaft (10, 10', 10'', 10''') have a connection by means of a rotationally fixed but radially movable or resilient coupling, which is preferably embodied as a polymer coupling (26).

9. Camshaft adjuster according to one of Claims 1 or 2, characterized in that a stop ring (22) is attached to the drive wheel (1) and has a lug (8) which engages in a corresponding, annular-segment-shaped cut-out (9), which limits the adjustment angle, of the output component (4).

10. Camshaft adjuster according to one of Claims 1 or 2, characterized in that a securing ring (20) whose external diameter corresponds at least to the tooth head diameter of the first ring gear (2) can be pressed into the latter.

11. Camshaft adjuster according to one of Claims 1 or 2, characterized in that at least the adjustment shaft (10, 10', 10'', 10''') can have cut-outs for the purpose of reducing the weight and/or can be composed of lightweight metal, plastic or a composite material.

12. Camshaft adjuster according to one of Claims 1 or 2, characterized in that at least one of the toothing components (3, 6, 28) is composed of lightweight metal, plastic or a composite material in order to reduce the weight.

13. Camshaft adjuster according to one of Claims 1 or 2, characterized in that all the components or individual components, preferably the toothing components (3, 6, 28), of the harmonic drive (19, 19') are fabricated in a non-material-removing fashion.

14. Camshaft adjuster according to Claim 5,

characterized in that the components of the harmonic drive (19, 19') are fabricated in a non-material-removing fashion, and the toothings (3, 6, 28) are subsequently hardened or nitrated.

15. Camshaft adjuster according to Claim 1, characterized in that the means for elliptically deforming the flexurally elastic sleeve (18) is a wave ring (11, 11') with an elliptical external circumference (12) and an elliptically deformed roller bearing (13, 13', 13'') attached thereto.

16. Camshaft adjuster according to Claim 5, characterized in that the means for elliptically deforming the flexurally elastic sleeve (18) is a wave ring (11, 11') with an elliptical external circumference (12) and an elliptically deformed roller bearing (13', 13'') attached thereto, and the external ring (15'') of the roller bearing (13', 13'') and the externally toothed sleeve (18) are embodied in one piece.

17. Camshaft adjuster according to Claim 15, characterized in that the elliptical wave ring (11') and the internal ring (14') of the roller bearing (13'') are embodied in one piece.

18. Camshaft adjuster according to Claim 2, characterized in that the bearing journals (29') are rotatably attached to the adjustment shaft (10''') using an eccentric fastening means and can be secured in any desired rotational angle position.

19. Camshaft adjuster according to Claim 2, characterized in that the roller bearings (13''') have eccentrically formed internal rings (25) which can be pressed onto the bearing journals (29) in any desired rotational angle position.

20. Camshaft adjuster according to one of Claims 1 or 2, characterized in that all or some of the camshaft adjuster components are manufactured by means of stamped packetization.